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Chapter 5. Advanced Technology Development Projects

5.1 Four-Part Project Management Process

5.1.a NASA advanced technology development (ATD) programs and projects are investments that produce entirely new capabilities or that help overcome technical limitations on a system-of-interest. This document distinguishes between basic and applied research programs and projects, on the one hand, and ATD programs and projects on the other. The principal distinction is that, in the former, a technologist is given adequate time and resources to prove the merits of a new concept, whereas in the latter, a concept has already been shown to be successful enough to warrant further investment in order to make it ready for application. NASA uses Technology Readiness Levels (TRLs) as a maturity measurement technique. (See Appendix F for a description of Technology Readiness Levels.) Basic and applied research generally reflects lower TRL levels, whereas ATD projects reflect TRLs 4 through 6. Because TRLs are somewhat subjective, some ATD projects may fall outside this range. ATD is seen as a bridge between basic and applied research and actual application in NASA or elsewhere.

5.1.b ATD projects may be a part of a program whose sole purpose is technology development, or they may be embedded in a flight systems and ground support program. In both programmatic structures, however, the Program Plan must designate its component ATD projects, and ATD Project Managers must comply with the requirements of the four-part management process described in Chapter 3 as clarified and modified by this chapter. Figure 5-1 shows the ATD project lifecycle.

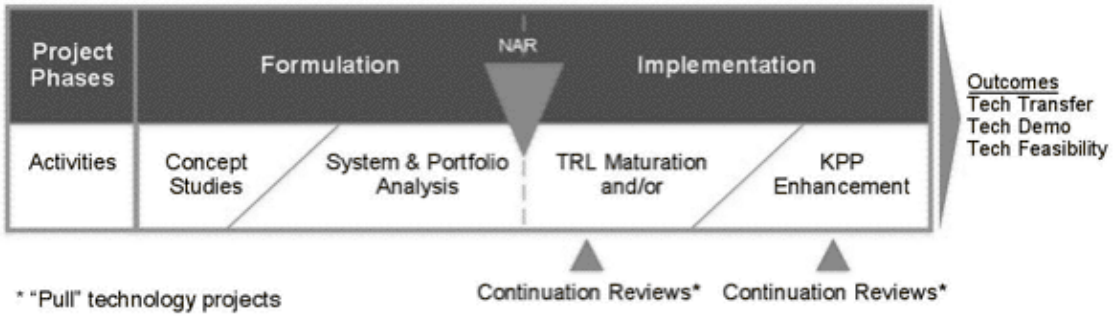

Figure 5-1. Advanced Technology Development project lifecycle

5.1.c ATD projects present unique management challenges. Often an ATD "project" (within NASA's budget and financial structure) is actually a large collection of tasks, each of which is small in budget and produces a discrete product or service. The Project Manager in this case coordinates the collection of tasks, but is required to create only one Project Plan. Occasionally, an ATD project will be large enough to be Category I or II.[34] In this case, additional management requirements are imposed.

[34] System-level X-type vehicles (such as the X-33) are examples of large ATD projects. For the purposes of determining project category, ATD Program and Project Managers should calculate LCC based on the entry and exit TRLs for the ATD project.

5.1.d NASA values technology infusion, whether into NASA flight projects or the U.S. economy as a whole. Flight projects and other users tend to embrace a new technology when sufficient maturity has been aptly demonstrated, and applicability to a mission or missions is abundantly clear. When a user "pulls" a technology into a mission or other use, the ATD Project Manager has successfully infused the technology. This requires close interaction with potential users of the new technology to overcome the many practical design and system integration challenges. To foster higher infusion rates, this document requires ATD projects to identify potential adopters and to ensure that progress is measured not only in terms of maturation level (TRL), but also through quantifiable key performance parameters (KPPs) important to those adopters. The combination of KPPs and TRLs not only enhances progress communication at key milestones, but also provides a more balanced assessment of risks and rewards in ATD projects.

5.2 Project Formulation

5.2.1 The work that constitutes formulation for an ATD project is mainly project planning and cost estimation. It is expected that some adjustment of management plans and products will be needed to comply with the requirements of Chapter 3, depending on the size, complexity, and priority of the ATD investment.

5.2.2 Requirements: The ATD Project Manager and the project team shall:

5.2.2.a **Perform technology portfolio analyses.** The Project Manager shall ensure that portfolio analysis studies are conducted to justify technology selections. Techniques such as Alignment Matrices, ROI vs. Risk Matrices, Technology S-curve Maps, etc. can be used to determine the best mix of technologies that will balance the project's risk posture.

5.2.2.b **Identify a set of project KPPs (a goal value and a threshold value for each).**

1. These KPPs shall be defined as the performance parameters associated with the end item delivery of the technology to the application community. The KPPs must consist of measurable engineering parameters that would be readily understood and used by engineers concerned with the ultimate application of the technology. For each KPP, the goal is the performance level that the project team is striving for, and the threshold is the minimum performance level that users agree is acceptable for the end item deliverable. Typically the threshold KPPs values are set beyond the current state-of-the art to warrant investment in the project.
2. When the ATD project contains multiple tasks and end items deliverables, KPPs shall be identified for each task or end item deliverable.

5.2.2.c **Complete the project estimate.**

1. With the cognizant Program Manager, the Project Manager shall establish a project cost estimate based on the delivery of technology end items with the agreed-upon KPPs at the required end TRL.
2. The basis of cost and schedule estimates, including defined reserves, shall be defined in relation to the goal and threshold KPP values.

5.2.2.d **Prepare a Project Plan containing the elements described in Appendix D, with the following modifications:**

1. In Part 2, Resources, the Project Manager shall employ the standard WBS template for the overall structure of the project.
2. In Part 2, Performance, the Project Manager shall describe the project's KPPs and establish the quantitative value for each to be achieved at each project milestone. This relationship can be in the form of a matrix that shows the KPP range (goal and threshold) and TRL to be achieved at each planned major demonstration or test.
3. In Part 2, Schedule, the Project Manager shall include a detailed schedule showing project milestones or planned major events. Managers are encouraged to identify alternative development paths in order to maximize the probability of success.
4. Only Project Managers of Category I and II ATD projects are required to complete Part 2, Acquisition Project Baseline.
5. Part 3, Technology Strategy shall be replaced with Part 3, Technology Insertion, and the Project Manager

shall describe how the technology end item deliverable(s) (product or service) will transition to application or user adoption (i.e., a technology transfer strategy). In this section of the Project Plan, the Project Manager shall maintain close integration with the application community, and provide an exit strategy following technology transfer.

6. Part 3, Reviews shall include a description of planned Continuation Reviews for technology pull projects. The Continuation Reviews are decision points for the users to determine if the technology maturation is still viable to meet the users' requirements. The Continuation Reviews shall have users' concurrence on their schedule frequency, participants, and review criteria.

5.3 Project Approval

5.3.1 To secure approval for ATD projects, the Project Manager shall ensure that project deliverables are clearly defined and that proposed plans allow for quantitative measurements of performance that can be objectively assessed. ATD projects, like other projects, are subject to a NAR with an independent cost estimate (for Category I and II projects) prior to implementation. ATD Project Managers are expected to update the Project Baseline for the NAR; upon approval, the project's NAR Baseline is formally established. The requirements of Section 3.3 apply to ATD projects with the modifications in Section 5.2 above.

5.4 Project Implementation

5.4.1 ATD project implementation requires continuing interaction between the project team and the user or application community.

5.4.2 Requirements: During implementation, the ATD Project Manager and the project team shall:

5.4.2.a Monitor cost and schedule for breaches as required by paragraph 3.4.3.2e. A breach for ATD projects is measured against cost and schedule growth. The Project Manager shall provide notification to the Program Manager, the MDAA, and the GPMC when the growth in the projected (or actual) cost and schedule needed to deliver the threshold KPPs exceeds ten percent (10%).

5.4.2.b Communicate progress to the Program Manager and user/application community.

1. The maturation progress of a technology at project milestones shall be measured using KPPs and TRLs.[35]
2. The Project Manager shall ensure that internal technical reviews of progress are conducted at each project milestone to validate achieved values for each KPP. The Project Manager should secure concurrence from the internal review team that the project has met the quantitative values for each KPP at the milestone prior to reporting progress to the Program Manager. The Program Manager reports maturation progress for each ATD project to the GPMC.

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[35] The use of "spider diagrams" to convey progress is encouraged but not required. In some technologies, TRLs may not be appropriate, and the Project Manager may substitute another form for describing maturation progress.

5.4.2.c The Project Manager shall ensure that changes to threshold KPPs established in the NAR Baseline are captured as part of updates to the Project Baseline.

5.5 Project Evaluation

5.5.1 It is expected that only rarely will ATD projects be Category I, so Project Managers will normally report to Center and Mission Directorate PMCs. Agency visibility into the progress of ATD projects will occur through program reviews at regularly scheduled QSRs at the Agency PMC, and through any reviews conducted by IPAO of programs containing ATD projects. The requirements of paragraph 3.5.3 apply.

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